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Light cannabis and organized crime.
Evidence from (unintended) liberalization in Italy

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Light cannabis and organized crime. Evidence from (unintended) liberalization in Italy

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Abstract

The effect of marijuana liberalization on crime is object of a large interest by social scientists and policy-makers. However, due to the scarcity of relevant data, the displacement effect of liberalization on the supply of illegal drugs remained substantially unexplored. This paper exploits the unintended liberalization of cannabis light (C-light, i.e. with low THC) occurred in Italy in December 2016 by means of a legislative gap, to assess its effect in a quasi-experimental setting. Although the liberalization interested all the Italian territory, the intensity of liberalization in the short-run varied according to the pre-liberalization market configuration of grow-shops, i.e. shops selling industrial canapa-related products that have been able to first place the canapa flowers (C-light) on the new market. We exploit this variation in a Differences-in-Differences design using a unique dataset on monthly confiscations of drugs at province level (NUTS-3 level) over the period 2016-2018 matched with data on the geographical location of shops and socio-demographic variables. We find that the legalization of C-light led to a reduction of 11-12% of confiscation of marijuana per each pre-existing grow-shop and a significant reduction of other canapa-derived drugs (plants of cannabis and hashish). Back-to-envelope calculations suggest that forgone revenues for criminal organizations amount to at least 160-200 million Euros per year. These results support the argument that, even in a short period of time and with an imperfect substitute, the organized crime's supply of illegal drugs is displaced by the entry of official and legal retailers.

Keywords: cannabis; marijuana light; crime; illegal market; diff-in-diff.

JEL codes: K23; K42; H75; I18.

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1. Introduction

According to the last European Drug Report (EMCDDA 2016), "*cannabis accounts for the largest share in value of Europe's illicit drug market*" and it is the most consumed drug worldwide (UNODC 2016). The illicit drug market is a long-standing problem in many countries. On the one hand, it constitutes an enormous source of revenues for the organized crime; on the other hand, it represents a cost for public authorities, e.g. for law enforcement and public health reasons. To tackle this problem, some countries have recently implemented a more liberal approach to the consumption of cannabis with the legalization and/or decriminalization of its use and commercialization. In the US, recreational marijuana is liberalized in several states (i.e. Alaska, California, Colorado, Maine, Massachusetts, Nevada, Vermont, and Washington) while Canada is expected to legalize it by the end 2018. Other countries and states have instead legalized only its medical use, which requires a doctor's prescription. However, the discussion on legalization has always been accompanied by divisive arguments. On the one hand, promoters of legalization usually argue that it would crowd out the illicit market, disrupt the organized crime and reallocate the police effort towards other crimes.[1] On the other hand, opponents of legalization sustain that eliminating the social stigma associated with the consumption of marijuana would induce more consumption (Jacobi and Sovinski 2016) and thus to negative effects on the social welfare.

Several studies have dealt with the effects of legalization, by studying its impact on crime (Adda *et al.* 2014, Shephard and Blackely 2016, Brinkman and Mok-Lamme 2017, Gavrilova *et al.* 2017, Hansen et al. 2017, and Dragone *et al.* 2018), health outcomes (DiNardo and Lemieux 2001, Wen *et al.* 2015, Sabia *et al.* 2017), consumption (Jacobi and Sovinsky 2016), and the presence of spillover effects, such as school and academic attainment (Plunk *et al.* 2016, Marie and Zolitz 2017), housing prices (Cheng *et al.* 2018), and traffic fatalities (Hansen et al. 2018).

The study of the impact of legalization on violent and non-violent crimes in the United States has attracted most of the attention of the economics literature. From a theoretical point of view, the entry of legal retailers of marijuana can have several effects on the market. Besides a potential market expansion of marijuana users, it makes the market more competitive, more transparent and solves the problem of moral hazard associated with the purity of drugs (see e.g., Galenianos and Gavazza 2017). Legal retailers can offer a controlled substitute product potentially displacing the demand and hence the equilibrium supply in the illegal market where the organized crime often operates in regime of monopoly. This prediction seems to be (only) indirectly supported by the empirical evidence. For instance, Hansen *et al.* (2017) use a regression discontinuity design to study how the legalization of marijuana impacted on "drug tourism". They exploit two different streams of legalization occurred in Washington and Oregon showing that when Oregon's legalized recreational marijuana, the quantity of marijuana sold in Washington fell by 41%. Hence, many Oregon's consumers were travelling to Washington to purchase legal marijuana and the inter-state spillovers displaced partly the equilibrium supply in the Oregon's illegal market. Gavrilova *et al.* (2017) study the impact of medical marijuana laws in the US on drug trafficking organizations. They find that the supply shock offered by the introduction of medical marijuana in the US caused a reduction of profits and therefore the incentive to settle disputes using violence.

Although these studies advance our knowledge on the impact of liberalization on crime, the interplay between the illegal and legal markets has not yet encountered a throughout examination. In particular,

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[1] In 2016, also the DNA, the National Anti-mafia and Anti-terrorism Directorate, expressed its positive opinion on the legalization of marijuana. Apart from the possibility to disrupting revenues for the organized crime, which is historically rooted in Italy, the DNA claimed that it would reduce the disproportion between the monetary and non-monetary costs of law enforcement and the small results obtained in terms of convicted criminals and drugs confiscated.

due to the scarcity of relevant data, the displacement effect of liberalization on the supply of illegal drugs remains substantially unexplored. This paper aims to fill this gap by testing the effect of legalization on the confiscations of drugs sold in the illegal market exploiting a quasi-experiment occurred in Italy. In December 2016, a legislative gap created the opportunity for legally selling cannabis with a low level of tetrahydrocannabinol (THC), a psychoactive chemical. As a result, some start-ups (e.g., *Easyjoint, Marymoonlight*) entered the market and started selling this *light cannabis* (C-light, henceforth). Traditional and online media covered widely the phenomenon, and, in April 2018, also a famous rapper, J Ax, launched its branded C-light, *Maria Salvador*, from the title of his famous song. This (unintended) marijuana liberalization represents an exceptional opportunity to test the changes in the (equilibrium) supply of street marijuana in a market where illegal and legal retailers co-exist. Italy is an interesting case study to test this effect for the presence of strong and organized criminal organizations (Mafia, Camorra, 'Ndrangheta and Sacra Corona Unita) that, more than any other country, entirely control the market of illegal substances often in partnership with international criminal organizations. Moreover, the market of cannabis-derived drugs represents around the 91.4% of the entire market of illegal drugs in Italy and a significant source of revenues for these organizations.

While the liberalization took place in the entire territory in the same period, the intensity of the liberalization in the short-run was not homogeneous. Specifically, from May 2017 onwards, after that the canapa flourishing process was completed, some shops specialized in the retail of industrial canapa-related products (i.e., grow-shop) started selling C-light on a franchising base exploiting large economies of scope, namely the possibility to sell, by means of the liberalization, both the canapa-related products and its flowers. These shops are located on the proximity to canapa cultivations which are concentrated in areas close to the waterways and humid soils (see Section 3.1 and Figure 2). In the following months, i.e., 1 year post-liberalization, also para-pharmacy, herbalist's and tobacco's shops did the same, exposing the Italian territory to a more homogenous market coverage. However, in the first year after the liberalization, the pre-existing stock of grow-shops at local level largely determined the local availability of C-light. In some places, the existence of grow-shops resulted in a high supply of C-light, while in some other places the absence (or the presence of very few) of grow-shop resulted in a low or zero supply of the C-light. As a consequence, after liberalization, areas with high numbers of grow shops have been more affected by the policy change than areas with low numbers of grow shops.

We exploit this variation to identify the effect of liberalization in a differences-in-differences (DiD, henceforth) framework. To this end, we have built a unique dataset running from 2016 to March 2018 built on several sources of data. Data including the quantity of illicit substances confiscated monthly in the Italian territory are made available by the National Police at province level (NUTS-3 level), i.e. the administrative division of intermediate level between a municipality (comune) and a region (regione). These data are then matched with data on the number of grow-shops active in Italy in 2016 at province level coming from official retailers' websites and collected by using Internet way-back machines. We finally link these data to province level socio-demographics variables provided by the National Institute of Statistics (ISTAT). An appealing and rare feature of this unique dataset is the availability of monthly data on confiscations. This feature, coupled with the unexpected nature of the liberalization, allows us to estimate the effect of interest in a very short time window around the policy (a maximum of eight months after). This makes changes in law enforcement and police effort extremely unlikely (and, however, controlled for in our estimates with the monthly number of police operations at province level) and allows to interpret any change in the amount of drug confiscated as changes in the equilibrium supply of illegal marijuana. This interpretation is also supported by anecdotal evidence, with consumers of C-light caught by the police and released without charge in the first months after the liberalization.

Under the hypothesis of a common trend in the confiscations across provinces with a different number of grow-shops pre-liberalization - that seems to be largely supported in our case (see Section 6) – our differences-in-differences strategy allows us to retrieve the causal effect of liberalization on the quantity

of illegal drugs confiscated. This effect is likely to represent a *lower bound* of the displaced supply of illegal drugs since confiscated drugs represent obviously only a share of the total illegal market.

We find that the legalization of C-light led to a reduction of 11-12% of confiscation of illegal marijuana per each pre-existing grow-shop. Interestingly, we find that liberalization impacted on also the illegal supply of other canapa-derived drugs, i.e. a reduction of 8% in the supply of hashish, and in the number of plants confiscated (37) per each grow-shop per province. Back-to-envelope calculations on the 106 provinces considered suggest that forgone revenues for criminal organizations amount to around 200 million Euros per year. Results are robust to a number of robustness checks, placebo regressions and alternative approaches to statistical inference.

The rest of the paper is structured as follows. In Section 2, we discuss the (unintended) policy change. In Section 3, a description of the dataset and main variables is provided. Identification strategy is presented in Section 4. In Section 5, we present the main results. Section 6 provides some sensitivity analyses and robustness checks while Section 7 summarizes and concludes the paper.

2. Institutional setting

In December 2016, the Italian government approved a law devoted to regulating and incentivize the production and commercialization of industrial canapa (also called hemp). Hemp has a variety of commercial use, ranging from food (e.g., canapa flour for pizza) to clothing, from therapeutical to construction use, as well as biofuel. Italy has a long tradition in the cultivation of hemp. In early 1900 and before the World War II, it was the second largest producer in the world just behind Russia. This is essentially explained by the presence of many waterways, which were essential for both the production of vapor energy and the yarn processing. Most of the production served for navy, army, railways, hospitals and tobacco industry. Nowadays, this heritage is reflected by the higher presence of canapa cultivations and canapa-related shops in the areas of the country closest to waterways and with humid soils (see Section 3.1 and Figure 2 for more details).

Industrial canapa contains a low level of THC, the psychoactive ingredient. The 2016 law while incentivizing the cultivation of this canapa did not intervene on the production of the flowers of canapa.[2] As a result of this legislative gap, after few months, in May 2017, some start-ups saw a profitable opportunity and started selling cannabis flowers with a low level of THC and a naturally high level of CBD, the cannabidiol. In theory, the flowers could not be consumed, eat or smoked. According to the labels applied to the pot, C-light could only be used for "technical" purpose, which means *nothing like anything*. Paradoxically, given its "technical use", minors of 18 years old could buy C-light but not tobacco.

As a matter of fact, an (unintended) legalization of C-light took place since May 2017, when fluorescence process was completed and the flowers were actually commercialized. Indeed, shops selling canapa-related products for industrial use (i.e. also known as grow shops), started to place the flowers on the market. This relies on the possibility of exploiting large economies of scope, namely the possibility of selling both canapa-related products and its flowers. As a consequence, in May 2017, the local availability of C-light branded by the major producers[3], was essentially determined by the presence of these shops. According to our data, this occurred in around 22 provinces in Italy but with a different intensity between these provinces which depends on the number of shops per province. As explained above, the geographical concentration of grow-shops is largely historically rooted being related to the

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[2] Only in May 2018, the Italian Government formally authorized the market for cannabis inflorescences with a low level of THC.

[3] The main producers are: Easyjoint, Marymoonlight, Real Hemp, XXXJoint. We use the Internet way-back machine to retrieve, form their websites and Facebook pages, the number of stores offering C-light.

existence of canapa cultivations, which tend to be concentrated in humid soils and close to large waterways. The pre-liberalization market configuration of grow-shops represents than a useful source of exogenous variation in the local availability of C-light.

Our strategy is likely to hold to recover the causal effect of the policy in the short run (i.e., up to one year after the liberalization). Indeed, in the long run, the selling of C-light was not only circumscribed to grow-shops. The C-light went so popular that also herbalist's shops, tobacco's shops, para-pharmacists started selling it, covering most of the Italian provinces with different intensities and timelines. In February 2018, 87 out of 106 provinces covered in our study were served by at least one in-store retailer.

Italy is an interesting case study for the analysis of the displacement effect of C-light liberalization on the illegal drug market. Indeed, as it is well-known, Italy has been historically pervaded by the presence of the organized crime with four main criminal organizations born in the southern regions (Camorra in Campania, Sacra Corona Unita in Apulia, 'Ndrangheta in Calabria, Stidda and Mafia in Sicily) but operating on the Italian whole territory. Drug trafficking is the most important activity pursued by these organizations often jointly run with other international criminal organizations. Illegal revenues from the consumption of drugs account for 14.2 billion Euro in Italy alone. The market of cannabis-derived drugs represents around the 91.4% of the entire market of illegal drugs corresponding to around 3.5 billion Euro (DNA 2017).

3. Data

Our empirical analysis is based on a unique dataset recording longitudinal information about all the 106 Italian provinces. We built the dataset merging information from several sources of data. Monthly data about drugs seized in each province by the police forces come from *Direzione Centrale per i Servizi Antidroga* (Central Direction for Anti-drugs Services), which plays a role of coordination of the Italian police forces with respect to anti-drugs operations. In particular, our dataset contains information about kilograms of marijuana, hashish, the number of cannabis plants and other substances monthly seized in each Italian province. Additionally, for all provinces, we collected information about the number of anti-drug operations conducted monthly by the police forces.

Moreover, we collected data about the pre-policy (October 2016) territorial diffusion of grow shops, which are stores devoted to the selling of cannabis-related products, as illustrated in the previous section, and that are used as treatment intensity variable in our empirical analysis. These data are collected through web scraping, analyzing the official websites of all the producers and extracting information about the exact location and the opening date of the shop. In addition, we also collected data on the official dealers of C-light after liberalization. This information will not be used in our empirical strategy as it may be due to an endogenous entry of these shops on the market. However, we will use these data for descriptive analysis in Section 3.1. The data are then aggregated on a provincial basis. This leads to a balanced panel dataset composed of about 2,700 observations, for years 2016 through 2018.

Concerning demographic characteristics, we collected from ISTAT (Italian National Institute of Statistics) time-variant information about population size and density and the territorial extensions of the provinces, alongside with a dummy that takes value 1 if the province has a freight port, in order to control for international drug traffic and higher probability of confiscations relative to those provinces not served by maritime routes.

3.1 Descriptive statistics

The full list of variables included in our dataset is presented in Table 1, alongside with mean values and standard deviations. Concerning our outcomes of interest, monthly confiscations by Italian police forces at province level amounts to an average of 24 kilograms of marijuana, 12 kilograms of hashish and 80 plants of cannabis, respectively.

[Table 1 around here]

Compared to whole illegal drugs market and traffic, cannabis-derived substances (i.e., both herbal and resin) account for more than 90% of the total amount of confiscated drugs, according to our data.

However, there is large heterogeneity amongst provinces concerning the monthly confiscation, ranging from no confiscation to confiscation of grams and to maxi-confiscations (tons), often occurring when law enforcement arises with respect to large criminal organizations in partnership with foreign organizations. Therefore, the mean values mask a number of important features of our data about drugs confiscations. First, as shown in the non-parametric distribution reported in Table 2, the distribution is highly right skewed. Second, in our dataset, we observe many zeros in the confiscation that need to be taken into account in our empirical strategy.

[Table 2 around here]

Concerning the grow shops, there were on average 2.7 shops per province, in the pre-policy period but, also in this case, the mean value masks an high spatial heterogeneity. Figure 2 shows the spatial distribution of both grow shops (left) in the pre-policy period (October 2016) and C-light shops (right) in February 2018 over the Italian territory. Each province is coloured according to number of the shops existing in the territory.

[Figure 1 around here]

Panel A of the Figure 2 shows that grow-shops were located mostly in the provinces on the sea-side, in the Po valley (Pianura Padana) and in Veneto. These places are all close to water-ways and are characterized by the presence of very humid soils which make the cultivation of canapa, and thus its commercialization, more favourable. Same soil characteristics make favourable the cultivation of rice, for instance, that is indeed located mostly in the same parts of the country. As discussed in the Introduction, grow shops were the first to place the flowers on the market by exploiting large economies of scope given by the possibility of selling both canapa and its flowers. As a matter of fact, these shops faced very small marginal costs to add the new product to their catalogue.

Panel B of figure 2 shows that spatial heterogeneity reduced substantially in February 2018, i.e. 14 months after the liberalization. A comparison between Panel A and B of figure 2 reveals two interesting features. First, it shows that C-light retailers are more concentrated in the areas characterized also by a higher pre-policy concentration of grow-shops. This is not surprising since grow-shop were the first C-light retailers after the liberalization. Secondly, it shows that liberalization caused a massive entry in the market especially in provinces not previously covered by grow-shops. This interested essentially herbalists and tobacco shops. Geographical distribution of the grow-shops and of C-light retailers reinforces the idea that even though the policy was national, its treatment effect was rather heterogeneous in the short run - being the pre-policy shops not uniformly spread over the Italian territory- while it becomes to be more homogenous in the long run, i.e. in February 2018. This pattern is one of the main rationale for the decision of focusing on the short-run effect of the liberalization in our analysis (see Section 4 for more details).

Finally, with respect to the other covariates, it is important to highlight that there are on average about 15 anti-drugs operations per month in each province. This represents a huge effort in terms of both human resources and budget for the Italian law enforcement agencies.

4. Identification strategy

To identify the effect of the unintended legalization of C-light on the illegal drugs supply, we exploit the local availability of the product to set up a difference-in-difference study design. In fact, even if the legislative gap was national the treatment effect was rather heterogeneous over Italian territory in the short-run due to the differentiated extent of the physical availability of the product, as discussed in the previous section.

In particular, following the early approach by Card (1992), we employ a DiD with continuous treatment which uses the number of grow shop already existing in each province before the legalization as intensity treatment variable. As explained in Section 2, these shops were to first to sell C-light thanks to the opportunity of exploiting large economies of scope given by the possibility of selling both canapa-related products and its flowers. Distribution of these shops across provinces is driven by province-specific geographical and morphological factors which make the cultivation and selling of canapa for industrial use more favourable in some areas, as shown in Section 3. Importantly, this is likely to be essentially unrelated to local demand for illegal drugs which may instead determine an endogenous entry of shops to sell C- light.

The possibility of endogenous entry is essentially ruled out in our study also for two reasons. First, because of the particular nature of the liberalization process: the legalization was unintended, being a consequence of a legislative gap and, thus, unannounced. This rules out any possibility of anticipation effect. Secondly, our data recorded on a monthly basis allow us to compare variations in a very small windows after the time in which the legalization took place. This rules out the possibility of endogenous entry of shops to selling C-light, which instead happened only in the long run, i.e. 14 months after liberalization, as shown in Section 3.

The focus on a short time period after the legalization is also useful to rule out long-time trends in cannabis confiscation, which (if negative) might lead to upward biased estimates. This may be caused from both contraction in the demand and changes in the efficiency of law enforcements agencies towards drug war. Although the particular nature of the liberalization makes changes in law enforcements unlikely, the focus on this very short time windows make them even more unlikely in our study. In any case, in our estimates, we control for the monthly number of anti-drug operations conducted in each province, in order to further control for the police forces' effort towards drug repression.

Importantly, while the basic DiD compares two groups (treatment and control) over pre and post policy periods, in our framework the treatment variable is continuous and every observational unit is identified by the intensity of the exposure to the policy. A similar strategy has been used by other empirical papers, i.e. Gaynor et al. (2013) to test the impact of hospital competition on health care quality. In this framework, the impact of the legalization is identified by the interaction between the pre-existing number of grow shop and the dummy that identifies the post-policy period.

Thus, our model takes the following form:

$$Y_{i,t} = \beta_0 + \beta_1 Post + \beta_2 Post \times Shops + \beta_3 Shops + \beta_4 X_{it} + \varepsilon_{i,t}$$

where Y_{it} is the amount of drug (i.e., marijuana, hashish, plants of cannabis) confiscated at the time t in the province i, $Post$ is the indicator of the post legalization period and takes value 1 from May 2017 onwards and 0 otherwise, while $Shops$ is our treatment intensity variable, namely the number of grow

shops pre-policy. X_{it} is a vector of time-variant covariates that includes the number of anti-drug police operations and province-specific demographic characteristics (i.e., square km, total population and population density), while ε is the error term. To deal with the high presence of zeros in the outcome variable, as shown in Section 3.1, we use two main approaches. First, we use a Zero-skewness log transformation of the dependent variable. This allow us to have a more straightforward interpretation of the impact of the liberalization, i.e. on the share of illegal marijuana displaced. Second, we use a Tobit model specification. This leads to a quantification of the monthly amount (i.e. in kilos) of marijuana displaced that is useful in order to calculate the forgone revenues for the criminal organizations.

The main coefficient of interest is β_2, which measures the change in the illegal market supply post−legalization per each pre-policy grows shop. As known, this identification strategy relies on the common trend assumption, which requires that in absence of the (unintended) liberalization the trends in confiscation would have been parallel in the different provinces, independently from the presence of grow shops. In Section 6 we will test this key assumption in different ways encompassing both graphical, regressions techniques and alternative approaches to statistical inference. All these checks provide strong support to the common trend assumption in our setting.

5. Results

[Table 3 around here]

Table 3 reports our results from the DiD regression. Columns (1-2) present the results of the DiD regression with a Zero-skewness log transformation of our dependent variable, while Column (3) presents the results obtained when using the Tobit model. For all specifications, we report estimates that include standard errors clustered at province level that are robust to correlated province-level shocks in drug confiscations. The high number of clusters (106 provinces) should rule out any concerns around the validity of inference in our estimates. However, in Section 6, we demonstrate that our results are robust also to different approaches to statistical inference (i.e. randomization tests based on simulated liberalizations).

The coefficient of interest, *Post X Grow-Shops (2016)*, is negative and statistically significant in all specifications. Results shown in columns (1-2) suggest that the liberalization of C-light determined a reduction of 11-12% of confiscation of illegal marijuana for each pre-policy grow-shop. In other words, while the policy impacted all Italian provinces, those provinces served by grow-shops before the policy experienced a more intense reduction of the amount of seized marijuana. Results for Tobit model suggest that liberalization of C-light led to a reduction of approximately 6 kilos of street marijuana confiscation per pre-existing grow-shop. Notably, in all model specifications, the coefficient of interest supports the thesis that the liberalization of C-light displaced the market of illegal marijuana. This happened mainly in those provinces where grow-shops were located: the greater the number of grow-shops in the market, the greater the displacement effect. A startling result is that such a displacement arises also with an imperfect substitute of street marijuana, with a low level of THC. Moreover, such a displacement occurs despite a general increasing trend for the amount of confiscated marijuana. The coefficient of the variable *Post*, capturing the time trend in the months following the introduction of the policy, is always positive and significant. By contrast, the number of grow-shops positively affect the amount of street marijuana seized by police authorities only in the DiD model specification when controls are not introduced, while the it loses significant when the model is further enriched. Finally, the number of operations positively impact on the amount of the illicit substance seized: one more operation leads, on average, to an increase of 7-9% of marijuana confiscated, corresponding approximately to around 4 kilos when we use a Tobit model.

Marijuana is not the only drug derived from canapa available in our dataset. Hashish is also very common in Europe. It is the resin of the cannabis plants and it is a processed product, usually stronger and concentrated than marijuana. It is usually imported by Morocco and sold at a price of 8-11 Euro/gr. (ECCMDA 2016). Another weak substitute of marijuana are the plants of cannabis. These remain mainly a personal phenomenon rather than a crime-related phenomenon. Table 3 also shows that the legalization of light cannabis generated spillovers also on these other canapa-related drugs. Column (4) shows that for any pre-existing and active grow-shop, C-light liberalization caused a reduction of 37 plants of cannabis confiscated. Hence, this result suggests that those users who were previously auto-cultivating cannabis to control the entire fluorescence process simply start buying more C-light whose production process is highly controlled and certified. Column (5) of Table 3 suggests that liberalization of C-light led to a reduction of 8% of the street resin (i.e., hashish) confiscated by the national authorities. The impact of the other regressors is very close to the one shown in Section 5.

6. Robustness checks

In this section we deal with a number of robustness checks. Firstly, we check whether our results are robust to the presence of maxi-confiscation activities. As most of the important marijuana arrives via the maritime route (e.g., the Balkan route), the presence of freight ports in some province may artificially increase the quantity of drug confiscated in these provinces. We thus conduct a robustness check controlling for the presence of big freight ports at the province level. Table 4 presents the main results with and without freight ports. We show that the estimates of the DiD approach are identical regardless of the subsample considered, with a marginal effect of pre-existing grow-shop on marijuana confiscated of approximately 9-10%, thus very close to the one shown in Section 5.

[Table 4 around here]

As a second check, we deal with the validity of the common trend assumption in our setting. One usual concern when using a DiD model specification is that the results can be driven by pre-policy trends and by the presence of confounding effects. While the presence of confounding effects is rather limited in our case since the liberalization of C-light was unintended and the industry was not regulated in the past, we conduct several tests showing to ensure that the common trend hypothesis is satisfied. First, we make a graphical inspection of the common trend assumption. The graphical analysis of the common trend assumption in the basic DiD framework requires both groups to follow a parallel path. In Figure 2 we present pre-policy trends in marijuana confiscations according to quintiles of pre-policy grow shops at province level in order to verify the robustness of the assumption to different levels of the treatment variable. Interestingly, the different lines follow a very parallel path leading us to be confident about the credibility of the common trend hypothesis in our setting.

[Figure 2 around here]

However, in our framework, the presence of a treatment intensity variable makes the graphical solution less straightforward. Thus, we complement our graphical analysis with a placebo regression. We basically test the effect of a fake policy at May 2016 and we control for its effect up to the period covered by the real policy. In other words, we shorten our sample period and consider only the period running from January 2016 to April 2017 by anticipating the policy from May 2017 to May 2016. Indeed, because of the sample cut, the total number of observations considered is 1,676. As the number of grow-shops used in our main analysis refer to October 2016, we use a way-back time machine to collect data on grow-shops at March 2016, two months before the fake-policy.

[Table 5 around here]

Table 5 shows that a fake policy anticipated has no significant effect on the illegal marijuana confiscated at the province level. All other controls, such as the time trend, the number of operations, and the number of grow-shops at March 2016, are instead positive and highly significant.

Lastly, to reduce any residual concern about possible violations of common trend assumption, we also perform a permutation test based on Monte Carlo simulation. Permutations test allows also to explore the robustness of the results to assumptions about the structure of the error distribution. This is a strategy increasingly used in many empirical applications (i.e., Wing and Marier, 2014; Carrieri and Principe, 2018). Indeed, although we rely on a large number of clusters (106) in our empirical analysis, inference in DiD setting might be sensitive to the choice of the cluster unit and the approach to the statistical difference (Bertrand et al., 2004; Donald and Lang, 2007).

Formally, we randomly select a set of different time periods and treatment intensity (Month x Year x Number of Shops) in order to simulate the effect of a "fake legalization" and estimate the average treatment effect in our DiD framework by using the fake legalization in place of the real one. Then, we simulate the model 5,000 times and store the estimated coefficient in order to plot the non-parametric distribution of placebo estimates. The key assumption of this randomization test based on placebo laws is that the fake legalization should not generate any effect on the marijuana confiscation, since the time of the legalization is randomly assigned. Thus, on average, the estimated effect should be zero.

Figure 3 presents the non-parametric distribution of placebo estimates of the (unintended) legalization of *c-light* on marijuana confiscation. As the mean of the distribution is virtually zero, the estimator is unbiased. Moreover, the average treatment effect we estimate in our empirical analysis (about -11%) falls in the very extreme left tail of the distribution, increasing the confidence that the legalization-driven reduction in illegal marijuana supply we estimate is unlikely to be generated simply by chance.

[Figure 3 around here]

7. Conclusions

Marijuana is the most popular drug in Europe. According to the EMCCDA, approximately 7% of the European population smoked cannabis (23.5 million of people) in 2016, with a peak of approximately 13.9% amongst the young adults (17.1 million). In Italy, cannabis is even more popular in the young population, with 19% of young adults making use in 2016. However, as marijuana remains illegal, users face no alternative than buying it in the streets, generating revenues for those active in the black market. Proponents of legalization of cannabis identify in the possibility to divert revenues from the illegal yet untaxed market to the legal one as their main argument. However, a potential legalization of cannabis has always encountered a polarised discussion and, due to the scarcity of relevant data, the displacement effect of liberalization on the supply of illegal drugs remained substantially unexplored. The main purpose of this paper is to fill this gap.

We look at the effect of the legalization of a light pot in Italy, exploiting a quasi-experiment occurred in December 2016, by means of a legislative gap which created the opportunity for legally selling cannabis with a low level of tetrahydrocannabinol (c-light). To identify the effect of interest we exploit the fact that the intensity of liberalization in the short-run varied according to the pre-liberalization market configuration of grow-shops i.e. shops selling industrial canapa-related products that have been able to first place the canapa flowers (light cannabis) on the new market exploiting large economies of scope (i.e. the opportunity of selling both canapa-related products and its flowers). Pre-policy localization of these shops depends essentially on the proximity to canapa cultivations which are concentrated in areas close to the waterways and humid soils.

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We employ a unique data-set on monthly confiscations of drugs at province level (NUTS-3 level) over the period 2016-2018 matched with data on geographical location of grow-shops and socio-demographic variables. Several features of our analysis allow us to make a number of contributions to existing literature on the interplay between legal and illegal market of drugs. First, the availability of monthly data coupled with the unexpected nature of the liberalization allows to estimate our effect of interest in a very short time window around the policy (a maximum of eight months after). This makes changes in law enforcement and police effort extremely unlikely (and however controlled for in our estimates with the monthly number of police operations at province level) and allows to interpret any change in the amount of drug confiscated as changes in the equilibrium supply of illegal marijuana. Second, unlike previous evidence coming quite exclusively from the US, we estimate the displacement effect in a European country and, in particular, in a country where criminal organizations are historically-rooted, have a very strong monopolistic power and entirely control the smuggling of the drug often jointly with international criminals. Last but not least, the availability on data on confiscations allow also to quantify the amount of illegal drug displaced by the liberalization and then assess, although roughly, the foregone revenues for criminal organizations. This is useful in order to evaluate the main expected beneficial effect from a liberalization process.

According to our differences-in-differences estimates, for any grow-shop serving a local market before the policy, the legalization of light marijuana led to a contraction up to 12% of the monthly confiscation of street marijuana. This amounts to around to 6.5 kilos per each existing grow-shop at province level. We also find significant spillover effects on other canapa-related drugs, i.e. a reduction of 37 plants of marijuana cultivated illegally and of 8% of hashish per any grow-shop. These estimates allow a back-of-the-envelope calculation of the forgone revenues for the criminal organizations. Considering that the average number of grow-shop at province level is around 2.76 and that the marijuana price is estimated to be 7-11 Euros per gram (ECCMDA 2016), our estimates over the 106 provinces considered imply that forgone revenues due to C-light liberalization ranges from 159 to 273 million of Euros per year, on average. This refers to the only market of marijuana, thus excluding other canapa-related drugs such as plants of cannabis and hashish.

The implied forgone revenues, despite statistically different from zeros, are likely to be not very high if evaluated as a share of revenues for the entire market of illegal canapa-related drugs, estimated to be around 3.5 billion Euro in Italy. This may suggest to underplay the role of liberalization as a way to fight criminal organizations. However, it is important to highlight that we are able to estimate only a (very) lower bound of the real displacement effect of liberalization. This is for a number of reasons. First, because we use data on confiscations of illegal drug which represent obviously only a lower bound of the stock of marijuana available in the illegal market. Second, because we deal with a liberalization of a rather imperfect substitute of the marijuana available in the illegal market. Indeed, C-light presents low level of the THC and a naturally high level of CBD, the cannabidiol. As a consequence, it has much less recreational effect. Last but not least, liberalization was unintended and received very little attention by the media, at least in the short term to which our analysis refers to. This implies that product advertisement was very low, at least in the short run.

Despite that, our estimates indicate that even a mild form of liberalization, as the one occurred involuntarily in Italy, can accomplish the purpose of reducing the quantity of marijuana sold in the illegal market and the related revenues of the organized crime and this is likely to encompass also a variety of canapa-related drugs.

Our results have also a number of other interesting implications. Besides the positive effect on crime, our results show that a substitution effect on the demand side exists between high- and low-THC products. According to the EMCDDA (2016), the potency of the substance has been increasing in recent times, reaching an average percentage of THC in street marijuana of 10.8, with peaks of 22%, relative to a 0.2-0.6% of THC permitted by the current Italian regulation. Given the substitution

pattern, we may speculate that all potential consequences of the direct liberalization of recreational marijuana (e.g., negative effect on school attainment as shown by Plunk et al. 2016) are not likely to arise with this light substance. Evidences in this direction may inform policy-makers about a mixed approach to legalization which - on the one hand - diverts the illegal consumption towards the legal one disrupting the black market and - on the other hand - it also reduces the negative externalities associated with the abuse or misuse of these substances.

This paper also sets the ground for future research. This may also be devoted to investigate, in the Italian context, the effect of this mild form of legalization on violent and non-violent crimes. This aspect assumes, for instance, a particular relevance in the long-run with a more efficient reallocation of police resources towards the repression and prevention of other crimes. Lastly, it might be beneficial an assessment of the potential forgone tax revenues deriving from the C-light liberalization. This may represent another argument in favour of the liberalization especially in times, as the current ones, of strict public budget constraints.

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Figures and Tables

Figure 1. Distribution of Pre-policy Grow Shops and Post-policy C-Light Dealers
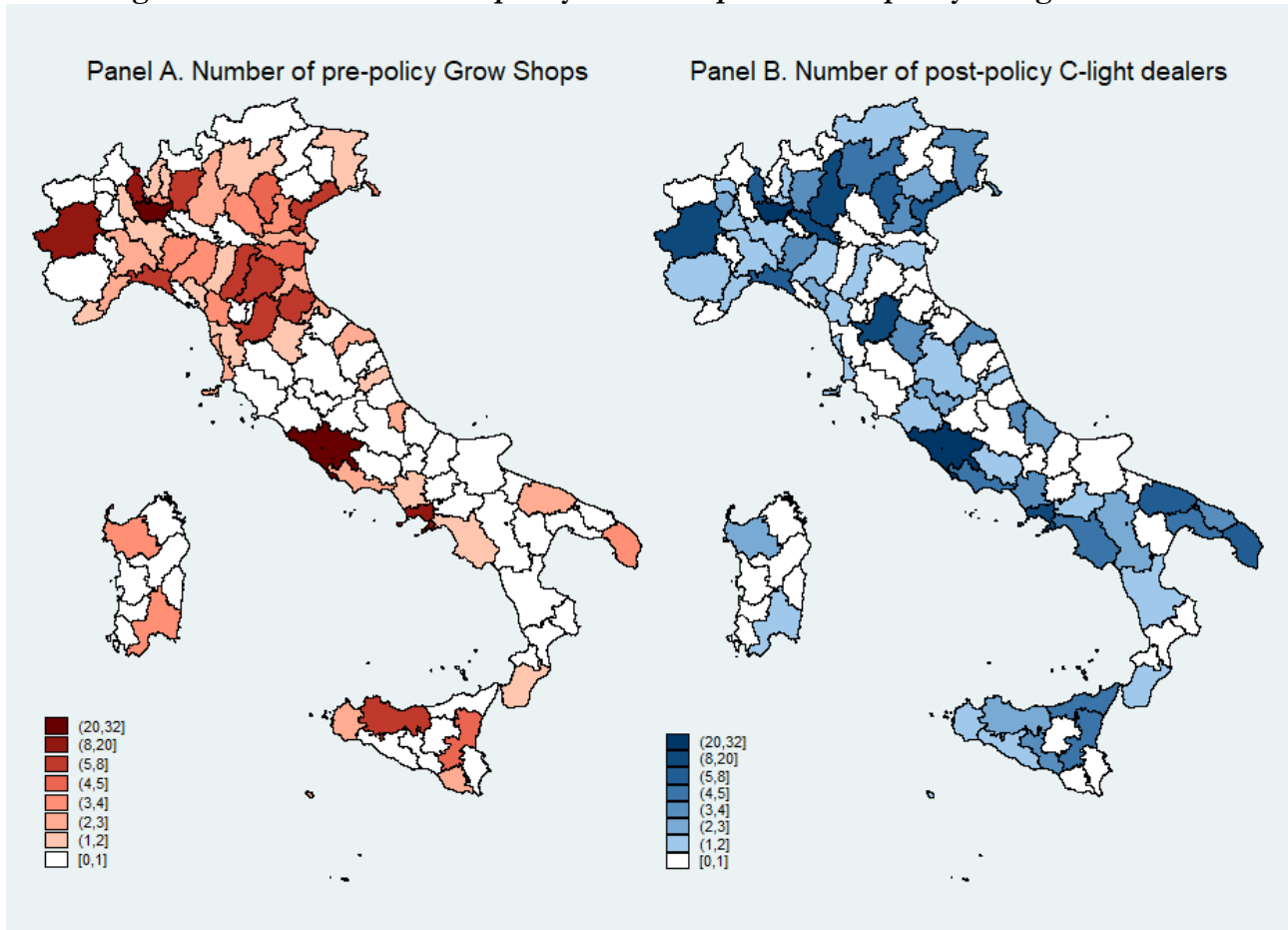
Panel A) shows the number of grow-shops selling canapa-related products before the introduction of the policy. The number of grow-shops refer to October 2016 and the data have been retrieved using the Internet wayback machine on the website http://www.growshopmaps.com/. Panel B) shows the number of post-policy dealers in February 2018. Data have been collected using the Internet wayback machine on the websites of the four major retailers.

Figure 2. Kernel density distribution of placebo legalization

kernel = epanechnikov, bandwidth = 1.628e-07
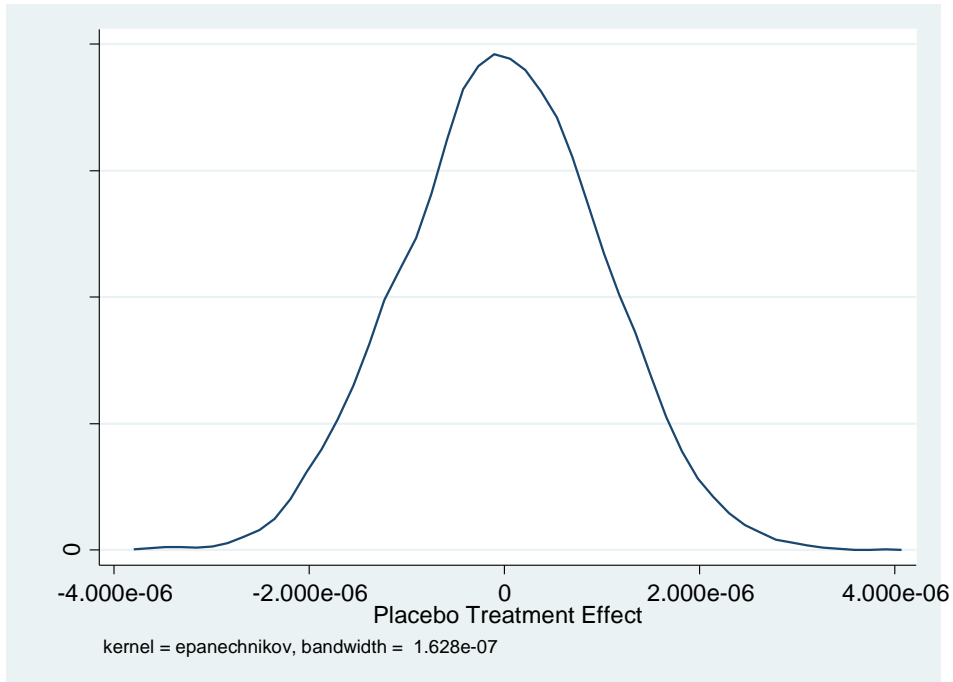
Kernel density distribution of placebo legalization based on 5,000 simulations.

Figure 3. Common Trend – Monthly confiscation of marijuana per quintiles of pre-policy grow shops
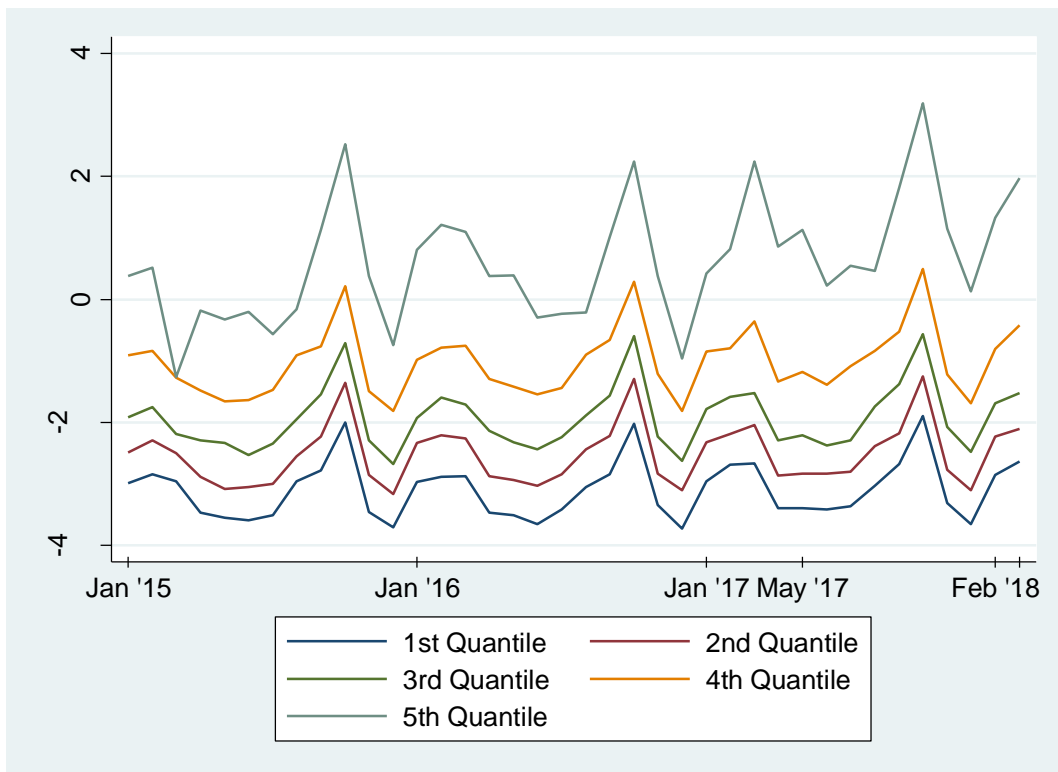
Table 1. Descriptive Statistics

Variable	Description	Mean	Std. Dev.
Marijuana	Monthly amount of Marijuana confiscated (in kilos)	24.21489	201.112
Hashish	Monthly amount of Hashish confiscated (in kilos)	12.15503	61.76634
Plants cannabis	Monthly number of plants of cannabis confiscated	80.67147	722.5947
Grow Shops*	Number of grow-shops pre-policy (October 2016)	2.764151	4.239946
C-light Shops**	Monthly number of retailers selling C-light post-policy	0.4883317	1.766226
Nr. Operations	Monthly number of police operations	15.29149	27.11157
Territorial controls			
Density		2.731.058	3.804.674
Population		572439.5	616444.5
Square km		2.849.744	1.738.862

Notes: The number of grow shops pre-policy has been collected using the Internet wayback machine http://archive.org/web/ on the website http://www.growshopmaps.com/. The number of C-light shops has been collected monthly using the Internet wayback machine on the websites of the four major retailers (Easyjoint, Marymoonlight, XXXJoint, Real Hemp) from May 2017 to February 2018.

Table 2. Distribution of Marijuana Confiscations: Summary Statistics and Percentiles

Mean	24.21
Standard Deviation	201.11
Skewness	22.04
Kurtosis	726.49
Minimum	0
P10	0
P25	.013
P50	.222
P75	2.122
P90	17.032
P95	51.218
P99	591.633
Maximum	8193.023

Note: Summary statistics and relevant percentiles of the monthly confiscation of marijuana. All Values expressed in kilograms

Table 3. Differences-in-Differences Regression

	(1) Log(Marijuana)	(2) Marijuana	(3) Marijuana	(4) Plants	(5) Log(Hashish)
Post X Grow Shops (2016)	-0.11***	-0.12***	-6.50**	-37.56***	-0.08**
	0.03	*0.03*	*2.66*	*13.79*	*0.04*
Post	2.15***	2.16***	57.51***	-46.18	0.76**
	0.33	*0.31*	*13.3*	*239.4*	*0.38*
Grow Shops (2016)	2.09	1.17***	452.66	1947.42	2.20
	6.3	*0.04*	*546.71*	*2851.22*	*4.27*
Nr. Operations	0.07***	0.07***	3.85***	15.13***	0.05**
	0.02	*0.02*	*0.65*	*3.41*	*0.02*
Other controls	Yes	No	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes
N	2756	2756	2756	2756	2756

(1), (2) and (5) Pooled OLS with Zero Skewness transformation of the dependent variable, (3) and (4) Tobit model. S.E. clustered at the province level *in italics*. ***, **, *, indicate statistical significance at 1%,5% and 10%, respectively.

Table 4. Differences in Differences Regression - With and Without Ports

	(1) Without Ports	(2) Without Ports	(3) With Ports	(4) With Ports
Post X Grow Shops (2016)	-0.09**	-0.10***	-0.09**	-0.09**
	0.04	*0.03*	*0.04*	*0.04*
Post	2.11***	2.10***	1.88***	1.80***
	0.39	*0.37*	*0.58*	*0.52*
Grow Shops (2016)	6.29	1.07***	-2.54	0.24***
	10.77	*0.11*	*7.92*	*0.01*
Nr. Operations	0.11**	0.11**	0.04***	0.04***
	0.04	*0.04*	*0.01*	*0.01*
Other controls	Yes	No	Yes	No
Ports	No	No	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
N	2080	2080	676	676

(1-4) Pooled OLS with Zero Skewness transformation of the dependent variable. S.E. clustered at the province level *in italics*. ***, **, * indicate significance at 1%, 5% and 10%, respectively.

Table 5. Placebo Policy: May (2016)

	(1) Log(Marijuana)
Post May (2016) X Grow Shops (Mar2016)	0.04
	0.05
Post May (2016)	1.82***
	0.40
Grow Shops (Mar2016)	1.83***
	0.09
Nr. Operations	0.09***
	0.02
Other controls	No
Province FE	Yes
Year FE	Yes
Month FE	Yes
N	1696

Pooled OLS with Zero Skewness transformation of the dependent variable. S.E. clustered at the province level *in italics*. Grow shops (Mar2016) refers to the number of grow-shops pre-existing the fake policy. These are collected using the Internet wayback machine for March 2016. ***, **, * indicate significance at 1%, 5% and 10%, respectively.